CHAPTER

1

INTRODUCTION TO WINDOWS XP PROFESSIONAL

After reading this chapter and completing the exercises, you will be able to:

- Describe the Windows XP product family
- Describe the major features of the Windows XP environment
- Understand the Windows XP intelligent user interface
- Define the minimum system requirements for Windows XP Professional
- Understand the two major networking models under which Windows XP can be used
- Understand the architecture of Windows XP

The pace of technological advances in the computing world is faster than ever before. Consumers can now purchase computer systems with power and capabilities that were mere fantasies just a few years ago, and do so at a lower cost. Microsoft has endeavored to remain competitive among these new powerful systems by continuing to improve its operating system (OS) products. The latest offering in the Microsoft OS product line is Windows XP, a network and desktop OS designed to take advantage of new hardware and the Internet to produce unsurpassed performance for network activities and application execution.

The Microsoft Networking Family

The Microsoft networking family is a collection of **operating systems (OS)**, each of which offers the capability of participating in a network as either a **server** or **client**. This family includes operating systems currently in production as well as older products. Products in production include Windows XP, Windows 2000, and Windows Me; older family members include Windows NT, Windows 98, Windows 98 Second Edition (SE), Windows 95, and Windows for Workgroups.

Windows XP Family

The Windows XP product family builds upon the best features of Windows 2000 and Windows 98/SE/Me, and includes advanced Internet, security, and connectivity technologies. The result is a network and desktop operating system that offers unsurpassed functionality, security, resource management, and versatility. Windows XP currently consists of two products: Windows XP Professional and Windows XP Home. Microsoft has also released a 64-bit version of Windows XP Professional to operate on the new Iridium Intel 64-bit processor. Because 64-bit technology requires very expensive hardware, it most likely will not be widely deployed by home, business, or educational communities. Additionally, this technology is not mentioned on the 70-270 certification exam.

The Home version of Windows XP is designed for standalone home use. It is basically the same OS as Windows XP Professional, but does not support several of the business-level features, including Encrypting File System (EFS), **domain** client capability, offline files, Internet Protocol Security (IPSec), Automated System Recovery (ASR), Remote Desktop, and Internet Information Server (IIS). For a complete list of "missing" features, see the *Microsoft Windows XP Professional Resource Kit*.

Windows XP Professional can be used as a stand-alone system or can be a workgroup or domain network client. Designed for speed and reliability, Windows XP Professional brings a solid computing environment to desktop and mobile computers. Windows XP Professional is the ideal client operating system for connecting to and interacting with a Windows 2000 or .NET domain. The majority of this book focuses on this product.

The Windows XP family will be expanded by the Windows .NET product line. Windows XP and Windows .NET were originally combined under the project name "Whistler." However, Microsoft decided to develop the server products of Whistler much further than the client products. As a result, the client products (Windows XP Professional and Windows XP Home) were released in October of 2001. The Windows .NET server products will not be released until sometime in early 2002.

When Windows .NET is finally released, it will most likely consist of three products: Windows .NET Server, Windows .NET Advanced Server, and Windows .NET DataCenter Server. .NET Server has gone through several name changes: originally Whistler, then XP Server, 2002 Server, and .NET Server. It is possible that Microsoft

will once again change the final product name and even alter the names of Advanced Server and DataCenter Server to meet new marketing demands.

Windows .NET builds on Windows 2000, borrows heavily from Windows XP, and includes numerous new advances as well. Windows .NET is a platform for Microsoft's XML Web services. Basically, a Web service consists of application logic that provides data and services to other applications. The Extensible Markup Language (XML) Web service technology allows applications to access Web services through Web protocols and formats such as Hypertext Markup Language (HTTP), XML, and Simple Object Access Protocol (SOAP), with no need to worry about how each Web service is implemented. This platform will revolutionize how applications and network services are distributed to network clients and even individuals. Microsoft is moving toward a subscription-based application service. Such a service would not offer boxed software products; you would lease usage time for applications over the Internet. As the .NET product line solidifies, keep an eye on the Microsoft .NET Web site for new and updated information: *www.microsoft.com/net/*.

Other Client Operating Systems

Microsoft's Windows product line includes several client operating systems in addition to Windows XP Professional, including Windows 2000 Professional, Windows NT 4.0 Workstation, Windows Me, Windows SE, Windows 98, Windows 95, and Windows for Workgroups. Any Microsoft Windows client system can be used on a Microsoft network. However, the old platforms typically support fewer network capabilities than the new platforms. Only Windows XP Professional, 2000, and NT clients can actually become domain members. All other client operating systems can access domain shared resources but are not true domain members. See the "Domain Model" section later in this chapter.

For more information on earlier Windows operating systems, see the Microsoft Web site: *www.microsoft.com/windows/*.

The Windows XP Environment

The Windows XP operating environment is a hybrid of Windows 2000 and Windows Me. The combination of the Windows 2000 core reliability and security with the Windows Me **Plug and Play** capability and connectivity has produced an operating system that is unsurpassed in function and features. The following sections highlight many of the characteristics of the Windows XP environment.

Multiple Processors

Windows XP Professional supports true **multiprocessing**; support for up to two CPUs is included in every standard version of Windows XP Professional. Windows XP Home can support only a single CPU. Windows .NET Server will most likely support four

CPUs, and the more advanced server versions will probably have even greater CPU capacity.

On multiple-CPU systems, as many processes or threads as there are CPUs can execute simultaneously; that is, if you are running Windows .NET Server on a system that has four CPUs, then four threads or processes can run at the same time. This means that multiple applications can execute simultaneously, each on a different processor. The network administrator can adjust the priority levels for different processors, to make sure that preferred applications get a bigger slice of the CPUs that are available.

Multitasking

One of the great features of Windows XP is **multitasking**, a mode of CPU operation in which a computer processes more than one task at a time. Windows XP supports two types of multitasking—preemptive and cooperative. **Preemptive multitasking** is a processor scheduling regime in which the OS maintains strict control over how long any execution thread (a single task within a multithreaded application, or an entire single-threaded application) may take possession of the CPU. This scheduling regime is called preemptive because the operating system can decide at any time to swap out the currently executing thread if a higher-priority thread makes a bid for execution; the termination of the lower-priority thread is called preemption. Windows XP supports multiple threads and allows duties to be spread among processors. Most native Windows XP applications are written to take advantage of threads, but older applications may not be as well equipped.

Cooperative multitasking describes a processor scheduling regime wherein individual applications take control over the CPU for as long as they like (because this means that applications must be well-behaved, this approach is sometimes called "good guy" scheduling). Unfortunately, this type of multitasking can lead to stalled or hung systems, should any application fail to release its control over the CPU. Windows 3.x is one of the most familiar examples of this type of environment; it runs on top of **MS-DOS**, a single-threaded operating system. In contrast, native 32-bit Windows XP applications have no such limitations. The default for Windows XP is that all 16-bit Windows applications run within a single virtual machine, which is granted only preemptive CPU access. This guarantees that other processes active on a Windows XP machine will not be stymied by an ill-behaved Windows 3.x application.

Multithreading

Multithreading refers to a code design in which individual tasks within a single process space can operate more or less independently as separate, lightweight execution modules called **threads**. Threads are called lightweight execution modules because switching among or between threads within the context of a single process involves very little overhead, and is therefore extremely quick. A thread is the minimal unit of code in an application or system that can be scheduled for execution.

Within a process, all threads share the same memory and system resources. A **process**, on the other hand, is a collection of one or more threads that share a common application or system activity focus. Processes are called heavyweight execution modules because switching among them involves a great deal of overhead, including copying large amounts of data from RAM to disk for outbound processes; that process must be repeated to copy large amounts of data from disk to RAM for inbound processes. Under Windows XP, it normally takes more than 100 times longer to switch among processes than it does to switch among threads.

Multithreading allows an operating system to execute multiple threads from a single application concurrently. If the computer on which such threads run includes multiple CPUs, threads can even execute simultaneously, each on a different CPU. Even on single-CPU computers, threaded implementations speed up applications and create an environment in which multiple tasks can be active between the foreground (what's showing on the screen) and the background (what's not on screen). Windows XP is extremely adept and efficient at multithreading.

File Systems

Windows XP supports three file systems that can be used to format volumes/partitions on hard drives:

- **FAT (File Allocation Table)**—The file system originally used by DOS (actually, the Windows XP implementation is an extension of Virtual FAT [VFAT], which includes support for long filenames and 4 GB files and volumes). Windows XP FAT is also known as FAT16.
- **FAT32**—An enhancement of the FAT16 file system developed for Windows 95 OSR2, and included in Windows 98. Windows XP includes support for FAT32 primarily to gain the 32 GB file and volume size improvement over FAT16. FAT32 volumes created by Windows 95 OSR2 or Windows 98 can be mounted under Windows XP.
- **New Technology File System (NTFS)**—A high-performance, secure, and object-oriented file system introduced in Windows NT. This is the preferred file system for Windows XP.

Versions of Windows NT up through 3.51 (that is, not including NT 4.0 or Windows 2000) supported HPFS (High Performance File System), which was originally present in OS/2 and LAN Manager. Windows XP does not support HPFS.

Active Directory

Active Directory is the control and administration mechanism of Windows XP that is supported by Windows 2000 or Windows .NET Server to create, sustain, and administer a domain or group of related domains. Active Directory combines the various aspects of a network—users, groups, hosts, clients, security settings, resources, network links, and transactions—into a manageable hierarchical structure. Active Directory simplifies network administration by combining several previously distinct activities, including security, user account management, and resource access, into a single interface.

Windows XP Professional does not include support utilities for installing or managing Active Directory. However, by joining a domain, Windows XP Professional will interact with the Active Directory for all resource- and security-related communications.

Security

Windows XP incorporates a variety of security features with a common aim: to enable efficient, reliable control of access to all resources and assets on a network. Windows XP security features begin with a protected mandatory logon system, and includes memory protection, system auditing over all events and activities, precise controls on file and directory access, and all types of network access limitations.

Windows XP was developed to address the following business security needs:

- Enterprise isolation
- Multilevel security
- Auditing and resource tracking
- Isolation of hardware-dependent code

Also, numerous third-party companies offer security enhancements or extensions to Windows XP that cover everything from biometric authentication add-ons (allowing fingerprints or retinal scans to be used in controlling system access) to firewalls and proxy servers that isolate Windows XP-based networks from the Internet or other publicly accessible networks.

One of the more popular features of the Windows XP security system is the inclusion of the Kerberos v5 authentication protocol. Basically, Kerberos is used to authenticate a client to a server (that is, to ensure that they are both valid members of a domain) before communication between them is permitted.

Compatibility

Windows XP supports a wide range of applications through application subsystems that emulate the native environment of each application type. In other words, a virtual machine is created for each application, which is fooled into seeing itself as the sole

inhabitant of a computer system that matches its execution needs. Windows XP supports the following application types:

- DOS 16-bit
- Native 32-bit (**Win32**)
- Windows 3.1 and Windows for Workgroups 16-bit (**Win16**)

Windows XP Professional supports most Windows 95/98/2000-based programs, in particular Windows 32-bit business programs. It also supports MS-DOS-based programs, except for those that access the hardware directly.

Storage

Windows XP Professional supports huge amounts of hard disk and memory space:

- *RAM*—4 GB (gigabytes)
- *Hard disk space*—2 TB (terabytes) for NTFS volumes, 32 GB for FAT32 volumes, and 4 GB for FAT16 volumes

Connectivity

The Windows XP core OS supports a wide variety of networking protocols:

- **NWLink**—Microsoft's 32-bit implementation of Novell's NetWare native protocol stack, IPX/SPX (Internetwork Protocol Exchange/Sequenced Packet Exchange).
- **TCP/IP (Transmission Control Protocol/Internet Protocol)**—The set of protocols used on the Internet. This protocol suite has been embraced by Microsoft as a vital technology.

Windows XP is compatible with many existing network types and environments and has native support for the following:

- TCP/IP intranets/Internet
- Integrated remote access networks
- Macintosh networks
- Microsoft networks (MS-DOS, Windows for Workgroups, LAN Manager)
- Enhanced NetWare connectivity

System Recovery

Windows XP boasts the broadest system recovery mechanisms of any Windows OS to date. In addition to traditional backup capabilities and the automated self-protecting

mechanisms of NTFS and the Registry, Windows XP includes System Restore, Automated System Recovery (ASR), Recovery Console, device driver rollback, and numerous alternate boot options.

Remote Capabilities

Windows XP builds on the networking capabilities of the Windows product line by introducing more options for remote connectivity. Two such features are Remote Desktop and Remote Assistance. Remote Desktop allows you to access your office computer's user environment from a remote system as you would through a Terminal Services connection. Remote Assistance is used to invite a remote user to view or control your desktop, often to help you perform some work or configuration task.

Help and Support Services

Windows XP boasts the most comprehensive help system ever included in a Windows OS. The Help and Support Center offers several means to access information, including many step-by-step guides, topical and index organizations, and online help for new items.

Intelligent User Interface

Windows XP has a whole new desktop layout and look, which Microsoft has labeled the "user experience." The user experience is simply the task-based visual design of the operating system. The new user experience is fresh and easy to use, but not so different that you can't make use of existing Windows know-how. Over the course of writing this book, we were first a bit frustrated by the new layout and organization, but within a week we found that we preferred the XP user experience over those of Windows 2000 or Windows Me. It seems more straightforward, more intelligent, and focused on getting things done.

Windows XP comes with a new default color scheme based on greens and blues, though the color scheme can be fully customized. If you prefer the boxy gray interface of Windows 2000, you can always switch over to the Windows Classic visual style. Additionally, Windows XP includes new 3D graphical elements and smoothing of edges and corners. The new look and feel is known as a visual styling, and is nothing more than a "skin" for the entire OS.

One of the most obvious changes to the interface is the Start menu. It appears too bulky at first due to its double-column format (see Figure 1-1). The left column of icons includes a quick line to a Web browser and e-mail client. Under these you can "pin" your own selection of icons (we've pinned Windows Explorer). Pinning is accomplished by right-clicking over an item anywhere in the Start menu and clicking on the Pin to Start menu command in the pop-up menu. Below the pinned items is a list of the most recently accessed applications. By default, only the last six are displayed, this can be extended up to 30. At the bottom of the column is the All Programs item, which contains

the rest of the Start menu subfolders and icons that were located within the Programs section of the Windows 2000 Start menu. The right column of the Windows XP Start menu includes quick links to My Documents, My Recent Documents, My Pictures, My Music, My Computer, My Network Places, Control Panel, Printers and Faxes, Help and Support, Search, and the Run command.

Figure 1-1 The Windows XP Start menu

As you explore the new Windows XP interface, you are bound to find many subtle changes and added features that make using the computer easier. Another interesting tweak is the improved taskbar. Within Windows XP, active application buttons on the taskbar are grouped by type. For example, if you have more than five or six applications running, two or three of which are Windows Explorer-type applications, they will be cascaded into a single taskbar button. This multi-application taskbar button will act like a pull-down list, enabling you to select the individual application with a single click. Windows XP offers a quick launch icon bar. It is disabled by default, but when enabled, it appears just to the right of the Start button. It's a great place to store often-accessed applications for quick one-click launching. Windows XP also has improved system tray icon management (note that Microsoft has altered this terminology—what was called the "system tray" in previous Windows versions is referred to as the "Notification Area" in Windows XP Professional). Instead of allowing icons to string out beside the clock taking up taskbar space, the inactive or rarely accessed icons are hidden. If you ever need access, just click the round arrow button to see them all. You can also custom-configure each icon as to whether it is always hidden, hidden when inactive, or always displayed.

For a hands-on tour of the new features of Windows XP's user interface, take the Windows XP tour offered to you during your first log on.

Overview of New Features

Windows XP includes a broad range of new features or improvements that add capabilities to the Windows product line. While most of these are not covered on the certification exams, you'll probably discover they are welcome additions to the previous versions of Windows.

Although IntelliMirror is not new, it has been fully integrated into Windows XP. IntelliMirror was first developed for Windows 2000. It offers a fault-tolerant system to protect system and data files from loss. It backs up user data, maintains user system configuration, automates application installation, and can even be used to deploy new clients. IntelliMirror is discussed in greater detail in Chapter 14, "Windows XP Professional Fault Tolerance."

Windows XP includes integrated video, voice, and text conferencing. As part of the Windows Messenger Service, Windows Messenger makes online collaboration easier and better than ever. With this tool you can trade contact lists, exchange files, share applications, and even write on a multi-user whiteboard. Communicating over an office LAN or the Internet has never been as elegant or as simple.

Windows XP sports the new Windows Media Player 8. The latest version of this Microsoft multi-media tool can be used to play CDs and DVDs, view recorded movies, play live or recorded music or local music files, search and organize digital media, copy music to portable devices, and even burn your own CDs.

Windows Movie Maker is a new application within the Windows environment. It enables you to transform your own camcorder recordings into amateur home movies. This multi-faceted application can combine video or audio from external analog and digital recording devices with downloaded content to produce a custom presentation. Just think, you can produce your own home movies if you can cut-and-paste, drag-and-drop, and point-and-click.

Windows XP has broader support for digital images than any previous version of Windows. This includes specialized media folders that operate like thumbnail depositories or slideshows right in Windows Explorer. Windows XP offers image manipulation and editing capabilities and quick access to online photo printing. You can submit your images to a print shop and have them shipped to you.

Autoplay is not a feature new to Windows, but Windows XP has taken Autoplay to a whole new level. Instead of automatically playing an audio CD or launching an application when a CD is inserted, you can custom-configure what the system does based on the type of CD. You can play the CD, open a slide show, print, and more.

Windows XP Professional Hardware Requirements

Windows XP Professional requires a minimum configuration of hardware to function. It is important that your system comply with these minimum requirements. However, in nearly all cases, you should attempt to purchase the fastest, largest, or best device you can afford. Compliance with the minimum hardware requirements only guarantees functionality; optimum performance requires exceeding these requirements. Here are the Microsoft-defined minimum requirements:

- 233 MHz CPU or higher microprocessor
- 64 MB of RAM (128 MB or more recommended; 4 GB maximum)
- 1.5 GB of free space
- SVGA (800 x 600) or higher resolution monitor
- Keyboard
- Microsoft Mouse or compatible pointing device (optional)

If you are installing from a CD-ROM drive, you'll need:

- A CD-ROM or DVD drive
- High-density 3.5-inch disk drive, unless you configured your PC to boot from the CD-ROM drive and can start the setup program from a CD, or if you have an existing OS that can access the CD-ROM drive

If you are installing over a network, you'll need:

- Windows XP-compatible network interface card (NIC) and related cable
- Access to the network share that contains the setup files

Hardware Compatibility List

When it comes to configuring a Windows XP machine, the Microsoft **Hardware Compatibility List (HCL)** is an essential piece of documentation. The HCL contains all known Windows XP-compatible hardware devices. The HCL also points to each device's driver, which may be native (included as part of the Windows XP installation program), on a subdirectory on the Windows XP CD, or available only from the device's vendor. Because Windows XP works properly only if a system's hardware is Windows XP-compatible, it's always a good idea to use the HCL as your primary reference when evaluating a prospective Windows XP system or when selecting components for such a system.

Finding the HCL

Finding the HCL is not always easy. The easiest place to look is on your Windows XP CD-ROM in the Support folder, where it exists as a text and a Help file. However, the HCL is not a static document; Microsoft's Quality Labs are constantly updating this file.

The version of the HCL on the Windows XP CD-ROM will quickly become outdated, because many new drivers and devices are introduced on a regular basis.

It's a good idea to consult the most current version of the HCL, especially when you'll be working with brand-new hardware. The most recent version of the HCL is available for online viewing through the Help and Support Center's "Find compatible hardware and software for Windows XP" link or on Microsoft's Web site: *www.microsoft.com/hcl/default.asp*. On the other hand, if you have access to a copy of the TechNet CD, a new copy of the HCL is published on TechNet each time it changes.

Why the HCL Is So Important

Windows XP controls hardware directly; it does not require access to a PC's BIOS (basic input/output system), as is the case with Windows 95/98 and earlier versions of DOS and Windows. Although this gives Windows XP a much finer degree of control over hardware, it also means that Windows XP works only with devices with drivers written specifically for it. This is especially true for SCSI adapters, video cards, and network interface cards.

Don't be misled into thinking that because a device works with previous versions of Windows, it will work as well (or at all) with Windows XP. There's no substitute for systematically checking every hardware device on a system against the HCL. Windows XP does support most hardware supported by Windows 2000 and Windows Me, but there may be exceptions.

In addition, it is important to note that Microsoft's technical support policy is that any hardware that is not on the HCL is not supported for Windows XP. If you ask Microsoft for support on a system that contains elements not listed in the HCL, they may blame all problems on the incompatible hardware and not provide any technical support at all. Instead, they may refer you back to the non-HCL device's manufacturer.

Fortunately, Windows XP automatically investigates your hardware and determines whether the minimum requirements are met and whether any known incompatibilities or possible device conflicts are present in the system. So, if you check out the major components manually on the HCL, you can probably get away with letting the installation routine check the rest of the system. If you *really* want to be sure, you can employ the Windows XP Hardware Compatibility Tool to detect your hardware and declare it compatible or not. This tool can be ordered online at: *www.microsoft.com/hwtest/default.asp*. Once this page loads, click the "System Testing Home" link, then click "System Test Kits and Procedures," click "Order," and finally, click "Order the Windows XP HCT 10.0." Additionally, you can run the WINNT 32 command with the /checkupgradeonly parameter to run the Upgrade Advisor. See Chapter 2, "Installing Windows XP Professional," for more information.

Preparing a Computer to Meet Upgrade Requirements

To upgrade a computer from a previous operating system to Windows XP, you must first verify that the components of that computer (CPU, memory, storage space, video, keyboard, mouse, etc.) match or exceed the minimum system requirements defined by Microsoft. To perform this activity, follow these steps:

1. Open the computer case.
2. Make a list of all present components, including model and manufacturer.
3. For each of the hardware requirements of Windows XP, verify that the component in your computer meets or exceeds the requirements.
4. For each additional component found in the computer, verify that it is listed on the HCL.
5. Remove any non-HCL compliant devices and replace them with HCL-compliant devices.
6. Proceed with your system installation.

NETWORKING MODELS

There are two networking models to which a Windows XP Professional computer can belong: a **workgroup** or a **domain**.

Workgroup Model

Microsoft's **workgroup model** for networking distributes resources, administration, and security throughout a network. Each computer in a workgroup may be a server, a client, or both. All computers in a workgroup are equal in stature and responsibility and are therefore called peers. That's why a workgroup model network is also known as a **peer-to-peer** network.

In a workgroup, each computer also maintains its own unique set of resources, accounts, and security information. Workgroups are quite useful for groups of less than 10 computers and may be used with groups as large as 25 to 50 machines (with increasing administration difficulty). Table 1-1 lists the pros and cons of workgroup networking.

Table 1-1 Pros and Cons of Workgroup Networks

Advantages	Disadvantages
Easy-to-share resources	No centralized control of resources
Resources are distributed across all machines	No centralized account management
Little administrative overhead	No centralized administration
Simple to design	No centralized security management
Easy to implement	Inefficient for more than 20 workstations
Convenient for small groups in close proximity	Security must be configured manually
Less expensive, does not require a central server	Increased training to operate as both client and server

Domain Model

By dedicating one or more servers to the job of controlling a domain, the **domain model** adds a layer of complexity to networking. But the domain model also centralizes all shared resources and creates a single point of administrative and security control. In a domain, it is recommended that any member act exclusively either as a client or as a server. In a domain environment, servers control and manage resources, whereas clients are user computers that can request access to the resources controlled by servers.

Centralized organization makes the domain model simpler to manage from an administrative and security standpoint, because any changes made to the domain accounts database will automatically proliferate across the entire network. According to Microsoft, domains are useful for groups of 10 or more computers. Microsoft estimates that the maximum practical size of a single domain is somewhere around 25,000 computers, but also describes other multidomain models that it claims have no upper limit on size. In real-world application, 3000 computers is believed to represent a reasonable upper boundary on the number of machines in a single domain.

No matter how many computers it contains, any Windows domain requires at least one **domain controller (DC)**. The domain controller maintains the domain's Active Directory, which stores all information and relationships about users, groups, policies, computers, and resources. More than one domain controller can exist in a domain; in fact, it is recommended that you deploy a domain controller for every 300 to 400 clients. Unlike domain controllers in a Windows NT 4.0 network, all Windows 2000 and Windows .NET domain controllers are peers. All other servers and clients on a domain-based network interact with a domain controller to handle resource requests. Table 1-2 summarizes the pros and cons of the domain model.

Table 1-2 Pros and Cons of Domain Networks

Advantages	Disadvantages
Centralized resource sharing	Significant administrative effort and overhead
Centralized resource controls	Complicated designs; requires advanced planning
Centralized account management	Requires one or more powerful, expensive servers
Centralized security management	Absolute security is hard to achieve
Efficient for virtually unlimited number of workstations	Expense for domain controllers and access lags increase with network size
Users need to be trained only to use clients	Some understanding of domain networks remains necessary
Not restricted to close proximity	Larger scope requires more user documentation and training

Windows XP Architecture

The Windows XP internal organization and **architecture** deeply influence its capabilities and behavior. The following sections explain the Windows XP operating system components and its two major operating modes in detail.

Windows XP is a modular operating system. In other words, Windows XP is not built as a single large program; instead, it is composed of numerous small software elements, or modules, that cooperate to provide the system's networking and computing capabilities. Each unique function, code segment, and system control resides in a distinct module, so that no two modules share any code. This method of construction allows Windows XP to be easily amended, expanded, or patched as needed. Furthermore, the Windows XP components communicate with one another through well-defined interfaces. Therefore, even if a module's internals change (or a new version replaces an old one), as long as the interface is not altered, other components need not be aware of any such changes (except perhaps to take advantage of new functionality that was previously unavailable).

All Windows XP processes operate in one of two modes: **user mode** or **kernel mode**. A **mode** represents a certain level of system and hardware access, and is distinguished by its programming, the kinds of services and functions it is permitted to request, and the controls that are applied to its requests for system resources. Each mode contains only those specific components and capabilities that might be needed to perform the set of operations that is legal within that mode. User mode and kernel mode are explained further in the following sections. The use of modes in Windows XP is very similar to their use in UNIX and VMS, and contributes to the modularity and built-in security mechanisms of Windows XP.

Windows XP is an object-oriented operating system; in user mode, any request for a system resource ultimately becomes a request for a particular **object**. An object is a collection of attributes with associated data values, plus a set of related services that can be performed on that object. Files, folders, printers, and processes are examples of objects. Because objects may be shared or referenced by one or more processes, they have an existence independent of any particular process in the Windows XP environment. Objects are identified by type (which defines what attributes and services they support) and by instance (which defines a particular entity of a certain type—for example, there may be many objects of type "file," but only one object can have a particular unique combination of directory specification and filename). Windows XP can control access to individual objects, and it can even control which users or groups are permitted to perform particular services related to such objects.

User Mode

All user interaction with a Windows XP system occurs through one user mode process. User mode is an isolated portion of the system environment in which user applications execute. User mode permits only mediated access to Windows XP system resources. In other words, any user mode requests for objects or services must pass through the Executive Services components in the kernel mode to obtain access. In addition to supporting native 32-bit Windows **APIs (application programming interfaces)**, a variety of user mode subsystems enable Windows XP to emulate Win16 and DOS environments.

Windows XP supports three core environment subsystems: Win32, Win16, and DOS. The Win32 subsystem supports Windows XP, Windows 2000, Windows NT, and Windows 9x 32-bit applications directly. Through the emulation of virtual DOS machines (VDMs) and Windows 3.x (WOWEXEC), Windows XP supports both DOS and Windows 16-bit applications.

Each subsystem is built around an API that enables suitable Win16 or DOS applications to run by emulating their native operating systems. However, even though other subsystems may be involved in some applications, the Win32 subsystem controls the Windows XP user interface and mediates all input/output requests for all other subsystems. In that sense, it is the core interface subsystem for applications in user mode.

As part of the Windows XP user mode, the security subsystem is solely responsible for the logon process. The security subsystem works directly with key elements in the kernel mode to verify the username and password for any logon attempt, and permits only valid combinations to obtain access to a system. Here's how: During a logon attempt, the security subsystem creates an authentication package that contains the username and password provided in the Windows XP Security logon window. This authentication package is then turned over to the kernel mode, where a module called the security reference monitor (SRM)—the portion of the security subsystem that verifies usernames and passwords against the security accounts database—examines the package and compares its

contents to a security accounts database. If the logon request is invalid, an incorrect logon message is returned to the user mode. For valid requests, the SRM constructs an access token, which contains a summary of the logged-on user's security access rights. The token is then returned to the security subsystem used to launch the shell process in user mode.

To gain access to the Windows XP logon interface (as a domain client or as a workgroup/standalone system in class logon mode), the user must enter a special key combination called the Windows XP attention sequence: Ctrl+Alt+Delete are pressed simultaneously. The attention sequence invokes the Windows XP logon process; because this key sequence cannot be faked remotely, it guarantees that this process (which also resides in a protected memory area) is not subject to manipulation by would-be crackers.

Kernel Mode

The kernel mode, which is a highly privileged processing mode, refers to the inner workings, or **kernel**, of Windows XP. All components in kernel mode take execution priority over user mode subsystems and processes. In fact, some key elements within the kernel mode remain resident in memory at all times, and cannot be swapped to disk by the Virtual Memory Manager. This is the part of the operating system that handles process priority and scheduling; it's what provides the ability to preempt executing processes and schedule new processes, which is at the heart of any preemptive multitasking operating system such as Windows XP.

The kernel insulates hardware and core system services from direct access by user applications. That's why user applications must request any accesses to hardware or low-level resources from the kernel mode. If the request is permitted to proceed—and this mediated approach always gives Windows XP a chance to check any request against the access permitted by the access token associated with the requester—the kernel handles the request and returns any related results to the requesting user mode process. This mediated approach also helps maintain reliable control over the entire computer and protects the system from ill-behaved applications. At a finer level of detail, the kernel mode may be divided into three primary subsystems—the Executive Services, the kernel, and the hardware abstraction layer (HAL)—each of which is discussed in the following subsections.

Executive Services

The **Executive Services** are the interfaces that permit kernel and user mode subsystems to communicate. The Windows XP Executive Services consist of several modules:

- I/O Manager
- Security Reference Monitor (SRM)
- Internal Procedure Call (IPC) Manager
- Virtual Memory Manager (VMM)

- Process Manager
- Plug and Play Manager
- Power Manager
- Windows Manager
- File Systems Manager
- Object Manager
- Graphics device drivers

The I/O Manager handles all operating system input and output, including receiving requests for I/O services from applications, determining what driver is needed, and requesting that driver for the application. The I/O Manager is composed of the following components:

- *Cache Manager*—Handles disk caching for all file systems. This service works with the Virtual Memory Manager to maintain performance. It also works with the file system drivers to maintain file integrity.
- *Network drivers*—Actually a subarchitecture in and of itself, network drivers are the software components that enable communication on the network.
- *Device drivers*—32-bit and multiprocessor-compatible minidrivers that enable communication with devices.

The Security Reference Monitor compares the access rights of a user (as encoded in an access token) with the access control list (ACL) associated with an individual object. If the user has sufficient rights to honor an access request after the access token and ACL are reconciled, the requested access will be granted. Whenever a user launches a process, that process runs within the user's security context and inherits a copy of the user's security token. This means that under most circumstances, any process launched by a Windows XP user cannot obtain broader access rights than those associated with the account that launched it.

The Internal Procedure Call (IPC) Manager controls application communication with server processes such as the Win32 subsystem—the set of application services provided by the 32-bit version of Microsoft Windows. This makes applications behave as if **dynamic link library (DLL)** calls were handled directly, and helps to explain the outstanding ability of Windows XP to emulate 16-bit DOS and Windows runtime environments.

The **Virtual Memory Manager (VMM)** keeps track of the addressable memory space in the Windows XP environment. This includes both physical RAM and one or more paging files on disk, which are called **virtual memory** when used in concert. The operation of the VMM will be discussed in more detail later in this chapter.

The Process Manager primarily tracks two kernel-dispatched objects: processes and threads. It is responsible for creating and tracking processes and threads and then for deleting them (and cleaning up) after they're no longer needed.

The Plug and Play Manager handles the loading, unloading, and configuration of device drivers for Plug and Play hardware. This manager allows the hot-swapping of devices and on-the-fly reconfiguration. Additionally, if a non-Plug-and-Play device uses a Plug-and-Play supporting device driver, it can be controlled through this manager.

The Power Manager is used to monitor and control the use of power. Typically, the services offered by the Power Manager are employed on notebook computers running on batteries or in other environments in which power is an issue. Some of the power-saving features offered include hard drive and CD-ROM drive power-down, video/monitor shutdown, and peripheral disconnection.

The Windows Manager introduces a method of network-based centralized control to Windows XP. It can be used to distribute software, manage systems remotely, and provide a programming interface for third-party management software.

The File System Manager is responsible for maintaining access and control over the file systems of the Windows XP environment. The File System Manager controls file I/O transfers for all the file systems.

The Object Manager maintains object naming and security functions for all system objects; it allocates system objects, monitors their use, and removes them when they are no longer needed. The Object Manager maintains the following system objects:

- Directory objects
- ObjectType objects
- Link objects
- Event objects
- Process and thread objects
- Port objects
- File objects

The Kernel

All processes in Windows XP consist of one or more threads coordinated and scheduled by the kernel. Executive Services use the kernel to communicate with each other concerning the processes they share. The kernel runs in privileged mode along with the HAL and the other Executive Services. This means that the kernel is allowed direct access to all system resources. It cannot be paged to disk, meaning that it must run in real memory. A misbehaving kernel process can stall or crash the operating system—a primary reason why direct access to this level of system operation is not available to user mode applications.

The Hardware Abstraction Layer

The goal of the **hardware abstraction layer (HAL)** is to isolate any hardware-dependent code in order to prevent direct access to hardware. This is the only module written

entirely in low-level, hardware-dependent code. It is the HAL that helps to make Windows XP scalable across multiple processors.

Memory Architecture

The memory architecture of Windows XP helps make this operating system robust, reliable, and powerful. As noted earlier, Windows XP Professional can manage as much as 4 GB of RAM.

Windows XP uses a flat (non-multidimensional) 32-bit memory model. It is based on a virtual memory, **demand paging** method that is a flat, linear address space of up to 2 GB allocated to each 32-bit application. Non-32-bit Windows applications, such as Win16 and MS-DOS, are managed similarly, except that all subsystem components, including the actual application, run within a single 2 GB address space.

The unit of memory that the VMM manipulates is called a **page**, 4 KB in size. Pages are stored to and retrieved from disk-based files called page files or paging files. These files are also used for memory reindexing and mapping to avoid allocating memory between unused contiguous space or to prevent fragmentation of physical memory.

Chapter Summary

- This chapter introduced you to the features and architecture of Windows XP. Windows XP Professional and Windows XP Home are both related to the up-and-coming Windows .NET Server product line. Windows XP offers a distinct operating environment that boasts portability, multitasking, multithreading, multiple file systems (FAT, FAT32, NTFS), Active Directory, robust security, multiple clients, multiple processors, wide application support, large RAM and storage capacity, and a wide range of network connectivity options. Windows XP is an inherently networkable operating system with built-in connectivity solutions for NetWare and TCP/IP, allowing easy implementation on multivendor networks.
- Windows XP has specific minimum hardware requirements; the Hardware Compatibility List (HCL) lists all devices known to be compatible with Windows XP.
- Windows XP can participate in either of two networking models—workgroup or domain.
- Windows XP is based on a modular programming technique. Its main processing mechanism is divided into two modes. User mode hosts all user processes and accesses resources through the Executive Services. The kernel mode hosts all system processes and mediates all resource access. The separation of modes provides for a more stable and secure computing environment. User mode supports the application subsystems that enable Windows XP to execute DOS, WIN16, and WIN32 software. Kernel mode's Executive Services manage all operations, including I/O,

security, IPC, memory, processes, Plug and Play support, power, distributed control, file systems, objects, and graphical devices.

- The Windows XP virtual memory model combines the use of both physical RAM and paging files into a demand paging mechanism to maximize memory use and efficiency. Windows XP is easy to use, offers new storage capabilities, provides improved Internet access, and maintains strict security.

KEY TERMS

Active Directory — A centralized resource and security management, administration, and control mechanism used to support and maintain a Windows 2000 or .NET domain. The Active Directory is hosted by domain controllers.

application programming interface (API) — A set of software routines referenced by an application to access underlying application services.

architecture — The layout of operating system components and their relationships.

client — A computer used to access network resources.

cooperative multitasking — A computing environment in which the individual application maintains control over the duration that its threads use operating time on the CPU.

demand paging — The act of requesting free pages of memory from RAM for an active application.

domain — A centralized enterprise model used in Microsoft networks.

domain controller (DC) — A computer that maintains the domain's Active Directory, which stores all information and relationships about users, groups, policies, computers, and resources.

domain model — The networking setup in which there is centralized administrative and security control. One or more servers are dedicated to the task of controlling the domain by providing access and authentication for shared domain resources to member computers.

dynamic link library (DLL) — A Microsoft Windows executable code module that is loaded on demand. Each DLL performs a unique function or small set of functions requested by applications.

Executive Services — The collection of kernel mode components designed for operating system management.

FAT (file allocation table) or **FAT16** — The file system used in versions of MS-DOS. Supported in Windows XP in its VFAT form, which adds long filenames and 4 GB file and volume sizes.

FAT32 — The 32-bit enhanced version of FAT introduced by Windows 95 OSR2 that expands the file and volume size of FAT to 32 GB. FAT32 is supported by Windows XP.

hardware abstraction layer (HAL) — One of the few components of the Windows XP architecture that is written in hardware-dependent code. It is designed to protect hardware resources.

Hardware Compatibility List (HCL) — Microsoft's updated list of supported hardware for Windows XP.

kernel — The core of the Microsoft Windows XP operating system. It is designed to facilitate all activity within the Executive Services.

kernel mode — The level where objects can be manipulated only by threads directly from an application subsystem.

mode — A programming and operational separation of components, functions, and services.

MS-DOS — One of the most popular character-based operating systems for personal computers. Many DOS concepts are still in use by modern operating systems.

multiprocessing — The ability to distribute threads among multiple CPUs on the same system.

multitasking — The ability to run more than one program at the same time.

multithreading — The ability of an operating system and hardware to execute multiple pieces of code (or threads) from a single application simultaneously.

New Technology File System (NTFS) — The high-performance file system supported by Windows XP that offers file-level security, encryption, compression, auditing, and more. Supports volumes up to 16 exabytes theoretically, but Microsoft recommends volumes not exceed 2 terabytes.

NWLink — Microsoft's implementation of Novell's IPX/SPX protocol, used for Microsoft Networking or for facilitating connectivity with Novell networks.

object — A collection of data and/or abilities of a service that can be shared and used by one or more processes.

operating system (OS) — Software designed to work directly with hardware to provide a computing environment within which production and entertainment software can execute, and which creates a user interface.

page — An individual unit of memory that the Virtual Memory Manager manipulates (moves from RAM to paging file and vice versa).

peer-to-peer — A type of networking in which each computer can be a client to other computers and act as a server as well.

Plug and Play — The ability of Windows XP to recognize hardware, automatically install drivers, and perform configuration changes on the fly.

preemptive multitasking — A computing environment in which the operating system maintains control over the duration of operating time any thread (a single process of an application) is granted on the CPU.

process — A collection of one or more threads.

server — The networked computer that responds to client requests for network resources.

TCP/IP (Transmission Control Protocol/Internet Protocol) — A suite of protocols evolved from the Department of Defense's ARPANet. It is used for connectivity in LANs as well as the Internet.

thread — The most basic unit of programming code that can be scheduled for execution.

user mode — The area in which private user applications and their respective subsystems lie.

virtual memory — A Windows XP kernel service that stores memory pages that are not currently in use by the system in a paging file. This frees up memory for other uses. Virtual memory also hides the swapping of memory from applications and higher-level services.

Virtual Memory Manager (VMM) — The part of the operating system that handles process priority and scheduling, providing the ability to preempt executing processes and schedule new processes.

Win16 — The subsystem in Windows XP that allows for the support of 16-bit Windows applications.

Win32 — The main 32-bit subsystem used by Win32 applications and other application subsystems.

workgroup — A networking scheme in which resources, administration, and security are distributed throughout the network.

workgroup model — The networking setup in which users are managed jointly through the use of workgroups to which users are assigned.

Review Questions

1. Which of the following application environments does Windows XP support as long as kernel mode/user mode restrictions are maintained?
   a. PICK
   b. SunOS
   c. OS/2
   d. X-Windows
   e. MS-DOS
2. Windows XP supports _____ of memory and _____ of disk space.
3. Which of the following are kernel mode components in Windows XP? (Choose all that apply.)
   a. Virtual DOS machines
   b. Security Reference Monitor
   c. hardware abstraction layer
   d. Win16 subsystem
4. Windows XP supports only cooperative multitasking. True or False?
5. Windows XP supports the HPFS file system. True or False?

6. Windows XP has inherent support for facilitating connectivity to which of the following? (Choose all that apply.)
   a. Novell NetWare
   b. Solaris printers
   c. Linux
   d. TCP/IP networks
7. Memory pages are stored in units of:
   a. 2 KB
   b. 4 KB
   c. 16 KB
   d. 64 KB
8. Windows XP Professional is the client product that came out of the Whistler development project. What is the server product that will come out of this development project?
   a. Windows XP Server
   b. Windows Advanced Server
   c. Windows 2000 Server
   d. Windows .NET Server
9. If you want users to share resources, but have no concern for local security on the system, which operating system would be your best choice?
   a. Windows 98
   b. Windows NT Workstation
   c. Windows XP Professional
   d. Windows 2000 Server
10. Which of these configuration specifications will allow for the installation of Windows XP Professional? (Choose all that apply.)
    a. Intel 233 MHz Pentium, 128 MB of RAM, 2 GB disk space
    b. Compaq Alpha, 48 MB of RAM, 2 GB disk space
    c. Intel 486DX/66, 16 MB of RAM, 800 MB disk space
    d. Intel 133 MHz Pentium, 24 MB of RAM, 2 GB disk space
11. A dual-boot computer hosts both Windows 98 and Windows XP Professional. You need to download an 8 GB datafile that will be used by both operating systems. What file system should you use to format the host volume?
    a. FAT
    b. FAT32
    c. NTFS

12. You are setting up a computer for the purpose of sharing files. Each user must have specific levels of access based on their identity. You also want the security system to employ encryption authentication to verify the identity of both the server and client before data transfer can occur. Which operating system would be the most effective solution?
    a. Windows 98
    b. Windows XP Professional
    c. Windows NT Workstation
    d. Windows XP Home
13. The two networking models supported in Windows XP are _____ and _____.
14. The three file systems supported in Windows XP are _____, _____, and _____.
15. When a user presses the Ctrl+Alt+Delete key combination in Windows XP after booting, what happens?
    a. The computer reboots.
    b. The logon screen appears.
    c. A "blue screen of death" occurs.
    d. A command prompt appears.
16. Windows XP runs on top of DOS. True or False?
17. Which of the following are required to install Windows XP on Intel-based computers?
    a. an SCSI CD-ROM drive
    b. a tape backup device
    c. a network interface card
    d. none of the above
18. Which of the following new features of Windows XP are system recovery mechanisms?
    a. ASR
    b. Autoplay
    c. System Restore
    d. Device driver rollback
19. Administrators desiring a centralized model of resource management should consider the _____ network model.
    a. workgroup
    b. domain

20. All direct access to hardware is mediated by which component?
    a. kernel
    b. Win32 subsystem
    c. hardware abstraction layer
    d. Executive Services
21. Windows XP Professional natively supports _____ processors.
    a. 1
    b. 2
    c. 4
    d. 32
22. Which of the following is a disadvantage of workgroup networking?
    a. Resources are distributed across all machines
    b. No centralized security management
    c. Efficient for virtually unlimited workstations
    d. Requires one or more powerful, expensive servers
23. Which of the following is an advantage of domain networking?
    a. Absolute security is hard to achieve
    b. Simple to design
    c. Centralized resource controls
    d. Inefficient for more than 20 workstations
24. When a DOS application that is used to manipulate files on a hard drive is launched on a Windows XP Professional system, in what mode does the process execute?
    a. user
    b. kernel
    c. protected
    d. IPC
25. Windows XP boasts which of the following abilities?
    a. burn CDs
    b. submit images for online printing
    c. video conference over the Internet
    d. create home movies

HANDS-ON PROJECTS

Project 1-1

To explore the desktop and Start menu:

1. Boot and log on to a Windows XP Professional system (which is a domain client or configured for Classic logon) by pressing **Ctrl+Alt+Delete**, then providing a valid username and password.
2. Notice the lack of icons on the desktop.
3. Double-click the **Recycle Bin**. This reveals all items that have been deleted but are still recoverable.
4. Select **File**|**Close**.
5. Click the **Start** button on the taskbar.
6. Notice the items that occur in the Start menu by default: Internet, E-mail, My Documents, My Recent Documents, My Pictures, My Music, My Computer, Control Panel, Printers and Faxes, Help and Support, Search, Run, Log Off, and Turn Off Computer.
7. Click **Turn Off Computer**. This reveals a dialog box where you can select to hibernate, turn off the computer, restart the computer, or cancel.
8. Click **Cancel**.
9. Select **Start**|**Run**. This reveals the Run dialog box, where you can enter or browse to a path and filename to launch.
10. Click **Cancel**.
11. Select **Start**|**Help and Support**. This opens the Help and Support Center interface. Explore this interface.
12. Close the Help system by clicking the **X** button in the upper-right corner of the dialog box.
13. Select **Start**|**Search**. This opens a menu with many selections: Each of these is an interface used to locate different types of objects, files, people, etc.
14. Select **File**|**Close**.
15. Select **Start**|**My Recent Documents**. This opens a menu that lists the most recently accessed documents or files.
16. Select **Start**|**All Programs**. This opens the first of several levels of menus in which all of the applications, tools, and utilities of the system are organized for easy access. Explore this multilevel menu.

17. Select **Start**|**My Documents**. This reveals the default storage location for your personal documents, faxes, and pictures.
18. Select **File**|**Close**.
19. Select **Start**|**My Computer**. This reveals a list of all drives present on the system, plus a link to the Control Panel.
20. Select **File**|**Close**.

Project 1-2

To view the Windows XP administration tools:

1. Select **Start**|**Control Panel**. This opens the Control Panel window.
2. If Control Panel is in category mode, click **Switch to Classic View**.
3. Double-click the **Date and Time** applet. This reveals the Date and Time interface, where the current time and date can be changed (see Chapter 3 for a complete explanation of this applet).
4. Click **Cancel**.
5. Double-click the **Fonts** applet. This reveals a list of all the fonts currently present on the system.
6. Click **Back** in the button bar to return to the Control Panel.
7. Double-click **Administrative Tools**. This reveals all of the administrative tools for Windows XP.
8. Double-click **Computer Management**. This opens an MMC console, where you can access information on a wide range of components. Explore this interface but be careful not to make any changes.
9. Close Computer Management by clicking the **X** in the upper-right corner of the window.
10. Close the Control Panel by selecting **File**|**Close**.

Project 1-3

To explore Task Manager:

1. Right-click over a blank area of the taskbar. This reveals a menu. Select **Task Manager** from the menu.
2. Take a look at the **Applications** tab of Task Manager. This lists all applications currently active in user mode.

3. Click the **Processes** tab of Task Manager. This lists all processes currently active. It also lists details about each process, such as its process ID, its CPU usage percentage per second, and its total CPU execution time.
4. Click the **Performance** tab of Task Manager. This tab shows graphs detailing the current and historical use of the CPU and memory. This tab also lists details about memory consumption, threads, and handles.
5. Click the **View** menu, then click **Show Kernel Times**. This alters the graphs so activities of the kernel mode are shown in red, and activities of the user mode are shown in green.
6. After watching this interface for a while, close it by selecting **File|Exit Task Manager** from the menu.

Project 1-4

To customize the desktop:

1. Right-click a blank area of the desktop.
2. Select **New|Shortcut** from the menu.
3. Click **Browse** in the window that appears.
4. Locate and select **Notepad.exe** in the main Windows XP directory (the default is WINDOWS). Click **OK**.
5. Click **Next**.
6. Click **Finish**. A shortcut to Notepad now appears on the desktop.
7. Right-click over a blank area of the desktop.
8. Select **Arrange Icons By**, then **Auto Arrange**.
9. Notice that the icons on the desktop have repositioned themselves in a uniform pattern.
10. **Right-click** over a blank area of the desktop.
11. Select **Properties**.
12. On the **Desktop** tab, take note of the current selection, then select an item from the list of background images.
13. Click **OK**.
14. To restore the desktop to its original settings, repeat steps 10 through 13 using the original setting. Delete the shortcut you created by selecting it and pressing the **Delete** key, then confirm the deletion.

CASE PROJECTS

1. You are planning a network in which users need to have a centralized location, where discretionary access control is a necessity. This will be an environment in which consistency is a must.

   Required Result:

   - All users must be able to access the server from any computer within the network through a single logon.

   Optional Desired Results:

   - Users must also be required to log on before accessing anything on their local machine.
   - Users will have the exact same desktop GUI.

   Proposed Solution:

   - Install Windows 2000 Server as the server platform. Establish a Windows domain. On half of the users' desktops install Windows 98, and on the other half install Windows XP Professional. Have all computers configured as part of the Windows domain.

   Which results does the proposed solution produce? Why?

   a. The proposed solution produces the required result and produces both of the optional desired results.
   b. The proposed solution produces the required result but only one of the optional desired results.
   c. The proposed solution produces the required result but neither of the optional desired results.
   d. The proposed solution does not produce the required result.

2. You have been instructed to evaluate the status of the network environment at Site A. Your goal is to evaluate the current network and determine, first of all, whether upgrading is necessary. If so, the next step is to determine which operating system will be the migration choice: Windows XP Professional or Windows 98. Finally, determine what steps are necessary before the migration can proceed.

Site A has 220 computers currently running Windows 3.1. They are running all 16-bit applications from the DOS and Windows environments. They plan on migrating to Microsoft Office 2000. Each computer has the following hardware configuration:

- Intel 486 DX4/100
- 8 MB of RAM
- 540 MB hard drive
- NIC (network interface card)
- VGA monitor

Users will not be allowed to share files at the desktop. They will not roam from computer to computer, so all of their files can be stored locally on their own computers.

Which migration path makes the most sense? Why?

a. No migration

b. Windows XP Professional

c. Windows 98

If migration to Windows XP Professional is necessary, what must be done to establish optimum but cost-effective performance?